Towards Socially Acceptable Autonomous Driving

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How Automated Vehicles should behave

AV System Design

How Automated Vehicles should interact

External HMI
Small central business area
in Campbell, California USA
Large boulevard roundabouts
Iranian cities
Seeing Socially: Beyond Computer Vision
Road users interact based on normal traffic assumptions (e.g. “that car is slowing down for me...”).

Will interactions with AV be the same? Will people sense or expect differences in AV behavior?

People dynamically adjust for many interacting agents.

Would additional signaling add to road users’ cognitive load?

Vehicle motion already communicates aspects of intent.

Would additional signaling assist in decision making, comfort and safety?

What kind of signaling would function the best?
NISSAN WORK ON EHMI

1. Understanding the Problem: Naturalistic Study

2. Develop solution concept: Indicator Signals

3. Initial test of understandability & effect: Remote Control Car

4. Extend feedback on understandability & design options: Survey

5. Roadtest of concept in action: WoZ car testing

6. Develop options for algorithmic development: Algorithmic concept

7. Multi-AV with Intention Indicator test

8. Industry Harmonization

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<tbody>
<tr>
<td>Going</td>
<td>Almost</td>
<td>Confuse with &quot;Starting to go&quot;</td>
<td>Red running backward (fast)</td>
</tr>
<tr>
<td>Planning to go</td>
<td>Almost</td>
<td>Confuse with &quot;Waiting&quot;</td>
<td>Flashing white</td>
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Intent Indication

✓ Be commensurate with vehicle system behavior
✓ Communicate its own state; not instruct others
✓ Be visible at road user line of site in motion
✓ Show discreet (vs. relative) signal-states
✓ Be passively discernable (at a glance); not require sustained or focused attention (eg. Avoid text)
THANK YOU!
FIELD STUDY WITH WIZARD-OF-OZ CAR

OBJECTIVE

Would Intention Indicator assist other road users in decision making in multi-agent setting?

STUDY DESIGN

SETTINGS

Small downtown setting
50 min. @ 6 pm
Test vehicle – Q50 with Intention Indicator
3 states: Stopping, About to Go, Going
21 Participants: Drivers (7), Walkers (9), Bicyclists (5)

DATA

Two 4-way stop Intersections: 37 Crossings
16 Cameras (4 fixed point, 3 on Q50, 9 on participants)
Survey (20), Focus Group Interview (21), Post Interview (8), Public Feedback
SIMULATED STUDY OF DRIVER INTERACTION WITH MULTI-AV

OBJECTIVE

How would other drivers respond when encountering multiple-AVs that were equipped with Intention Indicator?

STUDY DESIGN

33 participants, 4 groups

3 Configurations – Icon vs Light; 2 State vs 3 State

Subjective measurements – Interviews & Questionnaires

Objective measurements – Pedal Engagement & Eye-Glance Behavior